

## PARASITES OF MOTTLED SCULPIN, *COTTUS BAIRDI* GIRARD, FROM FIVE LOCATIONS IN UTAH AND WASATCH COUNTIES, UTAH

Richard A. Heckmann<sup>1</sup>, Allen K. Kimball<sup>1</sup>, and Jeffery A. Short<sup>1</sup>

**ABSTRACT.**—Between 1983 and 1985, 97 mottled sculpin, *Cottus bairdi* Girard, were examined from five collection sites in central Utah for parasites. Eight different species of parasites were observed, representing seven genera of Protozoa (*Plistophora*, *Myxidium*, *Myxobolus*, *Ichthyophthirius*, *Trichodina*, *Apiosoma*, *Eimeria*) and one genus of Nematoda (*Rhabdochona*). The highest number of parasites was found in sculpin from the Provo River near residential areas, while the lowest number was recorded from Hobbie Creek, a nearby pristine area. A complete list of parasites for *C. bairdi* with literature citations is presented. Each observed parasite is discussed emphasizing pathogenesis to the host.

During the past three years (1983–1985) we have examined populations of mottled sculpin, *Cottus bairdi*, from central Utah streams for parasites. Ninety-seven mottled sculpin were examined, representing five collection sites found in Utah and Wasatch counties of central Utah. Many studies pertaining to parasites of fishes center on hosts that have major importance to the commercial and sport-fishing industry. Even though nongame fish species represent potential reservoirs for parasites infecting the game fish, few studies have been published on this group. Hoffman (1967) summarized the literature for known species of parasites for the mottled sculpin. Since that date, one article on *C. bairdi* parasites has been published (Muzzall and Sweet 1986, Table 2).

The objectives of this study were (a) to survey *C. bairdi* from four localities in central Utah for parasites, (b) to update the current list of organisms utilizing the mottled sculpin as a host, and (c) to correlate parasite load with the sites selected that were based on impact from human populations.

Numerous surveys of freshwater fish parasites have previously been conducted in many parts of the United States. However, none of them include the mottled sculpin as the primary host, although several species of parasites were reported from *Cottus* spp.

The mottled sculpin has received little attention from parasitologists even though it supports many parasitic groups. Its benthic habit, population densities, water chemistry,

and stress may also influence the occurrence of many parasites. These factors appear to make the mottled sculpin an ideal model to monitor water pollution.

### MATERIALS AND METHODS

Ninety-seven sculpin (*Cottus bairdi*) were collected from five sites in Utah and Wasatch counties, Utah. Of these, 15 were collected below the state fish traps on the Strawberry River in Wasatch Co., 12 were collected in Hobbie Creek in Hobbie Creek Canyon, Utah Co., and 70 were taken during two years from two sites in the Provo River near the Brigham Young University campus in Utah Co. The sculpin were collected using electro-fishing gear and seines. They were then placed in buckets containing aerated river water and transported to Brigham Young University and kept alive in aquaria until examination. All fish were examined within two days after capture.

Each fish was examined for gross pathology after which blood samples were taken from peripheral circulation, stained, and examined for blood parasites. A gross ectodermal evaluation was followed by gill and fin scrapings that were observed microscopically. Sterile techniques were used on 10 fish to culture kidney macerate on blood agar to determine bacterial infections. The stomach, intestine, liver, gall bladder, and gills were removed and placed with saline in a separate dish for examination at both the gross and microscopic

<sup>1</sup>Department of Zoology, Brigham Young University, Provo, Utah 84602.

TABLE 1. Summary of parasites observed for the mottled sculpin, *Cottus bairdi*, during 1981 and 1982 from central Utah.

Sample location	Year	Nature of habitat	Number of fish examined	Parasites observed		
				<i>Pleistophora</i> sp.	<i>Myxidium</i> sp.	<i>Myxobolus</i> sp.
Provo River:						
Residential area	1981	Impacted	27	25.9	0	0
Farming area	1981	Impacted (less severe)	10	10.0	0	0
Provo River:						
Residential area	1982	Impacted	33	36.4	36.4	15.2
Hobble Creek (Canyon)	1982	Pristine	12	58.3	16.7	25.0
Strawberry River (Canyon)	1982	Pristine	15	0.0	13.3	26.6

levels. Any abnormal structures in the throat, stomach, liver, kidney, pancreas, and gall bladder were examined at 1,000X magnification. Methyl green-pyronine Y was incorporated as a vital stain to aid in observing protozoan parasites from host fish. Direct fecal smears were obtained from the intestine, and any coccidia found were stored in 2.5% potassium dichromate w/v. Nematodes were stored in 70% ethanol until identified. For identification, nematodes were cleaned and mounted in lactophenol on glass slides. Gill scrapings were stained with Gomori trichrome stain and silver nitrate (5% solution, Klines method). The musculature of the fish was teased apart, and any cysts found were fixed in buffered 3% gluteraldehyde and prepared through standard methods for electron microscopy.

Other parasites were fixed in 10% buffered formalin for future reference. Photographs were taken of fresh material and fixed material with light microscopy and electron microscopy techniques.

#### RESULTS AND DISCUSSION

A list of the parasites recovered during this study and their prevalence in infected fish is given in Table 1. Eight species of parasites were observed in varying rates of frequency from the examined fish.

The parasites recovered included both protozoan and helminth examples. Of these, *Trichodina*, *Ichthyophthirius*, *Apiosoma*, *Eimeria*, *Myxidium*, *Myxobolus*, and *Pleistophora* are common parasites of fish and are considered to have worldwide distributions (Kudo

1966, Hoffman 1967). The life cycles of these protozoa are direct; therefore, increased host density generally leads to an increased prevalence of the parasite. Although no formal host population estimates were made during the two years of the study, the host density seems to be high in one area of the Provo River where 17 sculpins were captured in two five-foot sweeps of the seine. This high density may account for the high prevalence of parasites in the residential area of Provo. The pathogenicity of the observed parasitic protozoa varies from genus to genus and primarily depends on the density of the parasite for each host.

All of the parasites recovered have been recorded previously in *Cottus bairdi* or other *Cottus* species in America with the exception of the *Myxidium* sp. of Kline. This genus was described from material taken in one cottid in China (Bykhovskaya 1962). According to Dogiel (1958), *Myxidium* is endemic to marine sculpin and has been used to study protozoan evolutionary pathways (Reichenback-Kline 1965). Table 2 lists the parasites of *C. bairdi* in North America with literature citations.

The sculpin in all five study areas contained bacteria cysts. Eighty percent of Strawberry River fish had cocci bacteria cysts in viscera and muscle. Ectodermal bacteria cysts occurred on 87.9% of the fish in the Provo River and on 25% of the fish in the Hobble Creek population. The bacterial cultures on blood agar made with host kidney tissue were negative.

Each parasite will be discussed separately with comments pertaining to host-parasite relationship.

Table 1 continued.

with percent infection for sample group					Number parasites observed	Range for parasite infection (%)
<i>Ichthyophthirius multifiliis</i>	<i>Trichodina</i> sp.	<i>Apiosoma</i> sp.	<i>Eimeria duszynskii</i>	<i>Rhabdochona cotti</i>		
14.8	0.0	40.0	3.7	62.9	5	14.8–16.9
30.0	55.5	40.7	40.0	80.0	6	10.0–80.0
0.9	0.0	45.5	40.0	42.4	7	0.9–45.5
0.0	0.0	0.0	12.0	58.3	4	12.0–58.3
0.0	0.0	0.0	0.0	0.0	2	13.3–26.6

TABLE 2. Summary of parasite genera currently listed for *Cottus bairdi* and *Cottus* sp. with reference to primary literature source (from Hoffman 1967 to current sources).

Protozoa	Trematoda	Cestoda	Acanthocephata	Nematoda	Arthropoda
<i>Apiosoma</i> <sup>E</sup>	<i>Bolbophorus</i> <sup>F</sup>	<i>Proteocephalus</i> <sup>D,L</sup>	<i>Acanthocephalus</i> <sup>K</sup>	<i>Camallanus</i> <sup>D</sup>	<i>Ergasilus</i> <sup>F</sup>
<i>Eimeria</i> <sup>C</sup>	<i>Bucephalus</i> <sup>F</sup>	<i>Schistocephalus</i> <sup>D</sup>	<i>Echinorhynchus</i> <sup>A</sup>	<i>Contracaecum</i> <sup>D</sup>	
<i>Epistylis</i> <sup>E</sup>	<i>Crepidostomum</i> <sup>F</sup>	<i>Triaenophorus</i> <sup>1</sup>	<i>Leptochynchoides</i> <sup>F</sup>	<i>Etonema</i> <sup>B</sup>	
<i>Ichthyophthirius</i> <sup>C</sup>	<i>Dactylogyrus</i> <sup>D,H</sup>		<i>Metechinorhynchus</i> <sup>D</sup>	<i>Haplomena</i> <sup>1</sup>	
<i>Myxidium</i> <sup>G</sup>	<i>Diplostomum</i> <sup>D,E</sup>		<i>Neoechinorhynchus</i> <sup>D</sup>	<i>Raphidascaris</i> <sup>1</sup>	
<i>Myxobolus</i> <sup>D</sup>	<i>Gyrodactylus</i> <sup>D</sup>		<i>Pomphorhynchus</i> <sup>F</sup>	<i>Rhabdochona</i> <sup>D</sup>	
<i>Plistophora</i> <sup>F</sup>	<i>Neascus</i> <sup>F</sup>				
<i>Trichodina</i> <sup>D</sup>	<i>Nezpercella</i> <sup>1</sup>				
	<i>Phyllodistomum</i> <sup>D</sup>				
	<i>Prohemistomum</i> <sup>F</sup>				
	<i>Rhupicotyle</i> <sup>F</sup>				
	<i>Tetracotyle</i> <sup>D</sup>				

## Reference to citation:

- A. Amin and Burrows 1977  
 B. Boyce 1971  
 C. Conder et al. 1980  
 D. Dechtiar 1972  
 E. Heckmann 1980, 1983  
 F. Hoffman 1967  
 G. Heckmann et al. 1986 (this paper)  
 H. Kritsky et al. 1977  
 I. Margolis 1979  
 J. Schell 1976  
 K. Schmidt et al. 1974  
 L. Threlfall and Hanek 1971

*Plistophora*: Microsporida

The small microsporidan *Plistophora* was observed in *C. bairdi* from four of the five collection sites. This group of protozoan parasites is characterized by size. Most microsporidan spores, often contained in cysts, average 2–3  $\mu\text{m}$  (Fig. 1). The *Plistophora* cysts were long, elliptical in shape, and oriented laterally in the host. The sporonts contained an average of 16 spores, which is characteristic of this genus (Fig. 2). The *Plistophora* from *C. bairdi* were found in musculature and had no affinity toward any specific location in the body of the host. The pathogenicity of the microsporidans can be quite severe due to their histozoic and coelozoic nature. Muscle deterioration can be ob-

served for infected tissue at the electron microscopy level of magnification (Figs. 3a, 3b).

The myofibrils of the skeletal muscle tissue are broken down near the large intracellular cyst masses (Figs. 3a, 3b). The 16 or more spores within the sporont have typical polar filaments and a single nucleus (Figs. 4a, 4b). *Plistophora* has been reported from sculpins previously (Table 2); however, species designation has not been published to date (Hoffman 1967).

*Myxobolus* and *Myxidium*: Myxosporida

Myxosporida is the largest protozoan group that infects fish (Kudo 1966). Myxosporidans have a worldwide distribution and are parasitic in all organs of fish. The life cycle begins



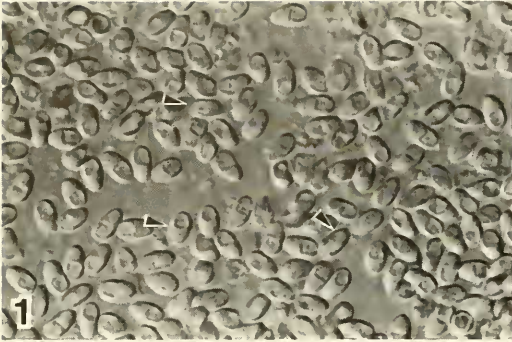


Fig. 1. Mature spores (arrow points) of *Plistophora* from the mottled sculpin, *Cottus bairdi*. Microsporidians are characterized by their size; for *Plistophora* the spores average 2–3  $\mu\text{m}$  in diameter. 1,100X.

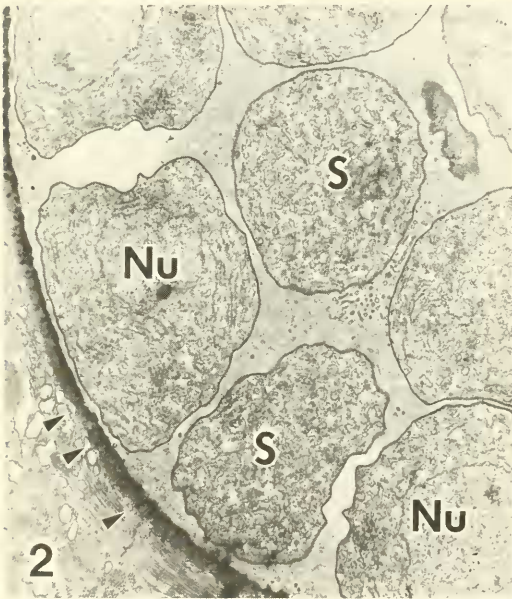


Fig. 2. Transmission electron microscopic micrograph of a sporont (arrow points) with developing spores (S). For *Plistophora* each sporont averages 16 developing spores. Note single nucleus (Nu) within developing spore. 13,800X.

with the ingestion of the spores by the host. In the host intestine polar filaments from the spore shoot out from the polar capsules (Reichenback-Kline 1965). Amoeboid embryos (amoebula) emerge and penetrate the intestine and move into organs and muscle tissue where the organism multiplies by plasmotomy. Plasmotomy stages were present in the cysts that accompanied the *Myxidium* spore for the infected gall bladder of mottled

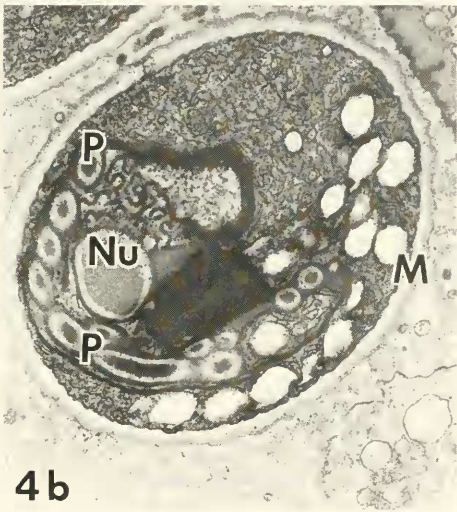
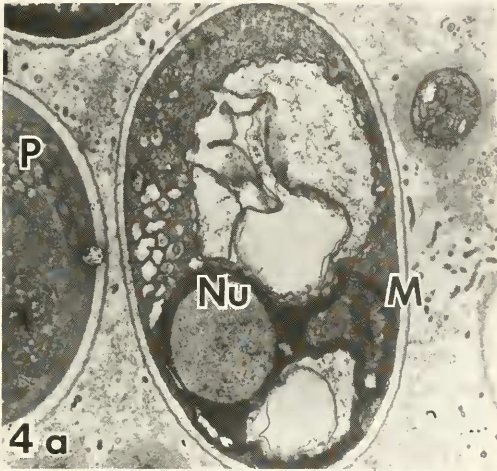


Figs. 3a, 3b. Transmission electron microscopic photograph of a sporont for *Plistophora* found in the musculature of *Cottus bairdi*. Skeletal muscle deterioration is occurring in the host tissue (arrow points). Spore maturity is characterized by the single polar filament (P) forming in the spore. The sporont wall (w) is corrugated and isolated developing spores from host tissue. 13,800X.

sculpin. The observed *Myxobolus* were taken from stomach tissue with the exception of two cysts that were present in the pectoral musculature and a gill arch.

The *Myxidium* spores (Figs. 5a, 5b) are fusiform with two polar capsules. The polar filaments were comparatively long. All spores were found in the gall bladder of mottled sculpin from three collection sites.

The other myxosporidian, *Myxobolus*, was collected from fish taken from three of the five collection sites. It invades stomach tissue, muscle tissue near the pectoral fin, and muscle tissue near the gill arches. The spores were ovoid in shape with two prominent polar capsules (Figs. 6a, 6b) at the anterior end. The



Figs. 4a, 4b. Mature spores of *Plistophora* infecting the musculature of *Cottus bairdi*. Note the single nucleus (Nu) for each spore, polar filament (P) wrapped around the inside of the multi-layered outer membrane (M). 4a, 13,800X; 4b, 28,000X.

Figs. 5a, 5b. Micrograph of *Myxidium* from the gall bladder of *Cottus bairdi*. A differential stain, Grams stain, was used for Fig. 5a to emphasize the two polar capsules (arrow points) per spore. Fig. 5b is stained with hematoxylin and eosin, emphasizing the sporoblast (S) inside the spore. 1,100X.

parasite was histozoic in nature occupying muscle tissue (smooth and striated) of the host.

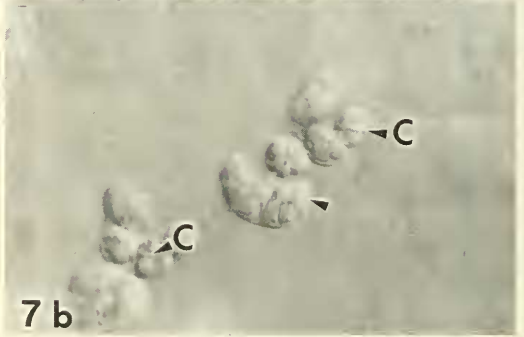
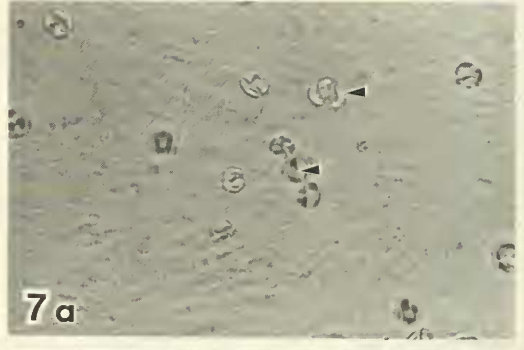
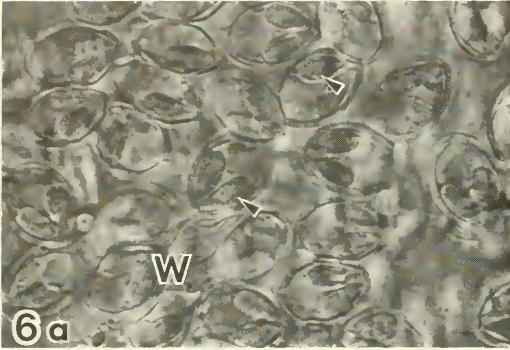
*Eimeria*: Sporozoa

Freshwater coccidians have been described from Europe, Asia, and North America (Molnar 1973). The genus *Eimeria* is characterized by eight sporozoites within an oocyst. *Eimeria duszynskii* was identified by the presence of crossbanding on the sporozoite end opposite the refractile body (Conder et al. 1980), at 1,000X magnification (Figs. 7a, 7b). This parasite inhabits the epithelium of the intestine

and develops through a life cycle of asexual and sexual phases (Hammond 1973). Schizogony is an asexual phase of the trophozoite that encysts in the small intestine. The cyst expels merozoites which differentiate into male and female gametes. In the sexual phase (gametogony) there is a gradual process of invasion into the lining of the intestine (Dogiel 1965). The zygote is passed out in the feces, and, following sporulation, it is taken in by another host. Spores multiply in an asexual phase (sporogony), followed by sporulation in the intestine (Figs. 7a, 7b).

The pathogenicity of coccidians in sculpins has not been described, but in other studies *Eimeria* has been shown to cause mortality in fish (Molnar 1973). The rupture of large numbers of intestinal cells is the chief pathology due to this parasite, and mortality can be associated with decreased ability to absorb nutrients, blood loss, and other physiologic stresses. The damaged tissue can cause physiologic stress and is subject to secondary inva-





Figs. 6a, 6b. The second myxosporidan observed in this study, *Myxobolus*, was found in stomach tissue and in skeletal musculature near the pectoral fin and gill arch. The characteristic spore wall (W) is visible for this sample. Using Nomarsky interference lighting makes the two polar capsules (arrow points) containing polar filaments prominent. 1,100X.

Figs. 7a, 7b. *Eimeria duszynskii* from the intestine of *Cottus bairdi*. The figures represent the sporogonous phase. Spores (arrow points) are released in fecal material whereby other fish can become infected. Note the cross-banding (C) of the sporozoite for Fig. 7b. This is characteristic for the species. 7a, 430X; 7b, 1,100X.

sion by other pathogens.

*Eimeria* was one of the most common parasites observed during this study. It was present in *C. bairdi* from four of the five collection sites. The type species for *E. duszynskii* came from infected fish of the Provo River, one of the sampling sites for this study.

*Apiosoma*, *Trichodina*, and  
*Ichthyophthirius*: Ciliata

*Apiosoma* is a small, stalked ciliate that attaches to gill surfaces (Figs. 8a, 8b). This ciliate is 35–44  $\mu\text{m}$  in size and has a characteristic single cone-shaped macronucleus (Hoffman 1970). *Apiosoma* is characterized by a holdfast (scopula) that attaches to the gill surface. There is no documentation to show that this parasite can cause major fish mortality, but the potential exists to kill its host. When present in large numbers, it could tax the respiratory surfaces of the gill lamellae. It was observed in mottled sculpin from the three

collection sites on the Provo River. *Apiosoma* numbers fluctuated with seasons, the highest numbers per fish being observed in the spring. Infected gill tissue containing *Apiosoma* was characterized by a fibrous host capsule surrounding the protozoan parasite. There has been only one species described to date infesting fish (Hoffman 1967).

In small numbers *Apiosoma* does not have pathogenicity, but in higher numbers it could create a blockage of the respiratory gill surface. *Apiosoma* was found infesting fish in the same aquatic sites as *Eimeria*.

*Trichodina* are ubiquitous ciliated protozoan parasites that infest the gill surfaces of fish. The ciliate rarely causes damage to its host. It will rapidly multiply on weakened hosts. It is characterized by three ciliary girdles (aboral) with taxonomically important, radially arranged hooked teeth or denticles (Fig. 9). There are many undescribed species in North American freshwater fishes (Hoffman 1967). For this study, mottled sculpin



Figs. 8a, 8b. The stalked ciliate, *Apiosoma*, which infests the gill surface of *Cottus bairdi*. Note the cilia (arrow points), macronucleus (Nu), holdfast (h) for host attachment, and large size (35–44  $\mu\text{m}$  in diameter). 8a, 430X; 8b, 1,100X. Nomarsky phase interference microscope lighting was used for this figure.

from a single site on the Provo River were infested with *Trichodina* (Table 1).

*Trichodina* has been associated with mortality where the level of infection is high and abrasion of the gill tissue is too severe for repair. This causes a physiologic stress on the animal, in addition to opening the area for secondary infections. In one instance, *Trichodina* sp. had a significant association with *Gyrodactylus* sp. (Noble 1961).

*Ichthyophthirius multifiliis* was recovered in gill material of *C. bairdi* taken from all three collection sites on the Provo River. This parasite is very common in freshwater fish and has a worldwide distribution. It has also been the cause of major catfish mortality (Hines and Spira 1973), and much research has been conducted to manage the disease (Farley and Heckmann 1980). This ciliate is one of the largest protozoan parasites for fish. During the trophozoite phase of its life history it can measure up to 1 mm in size and thus the name "white spot disease." It has a characteristic horseshoe-shaped macronucleus that is visi-

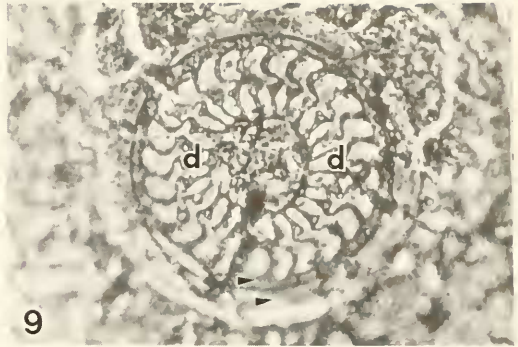


Fig. 9. *Trichodina*, a ciliated protozoan, from infested *Cottus bairdi* gills. Kliens silver stain method was used for emphasis of ciliary rows (arrow points) and denticles (d). Both characteristics are used to taxonomically describe species of *Trichodina*. 1,100X.

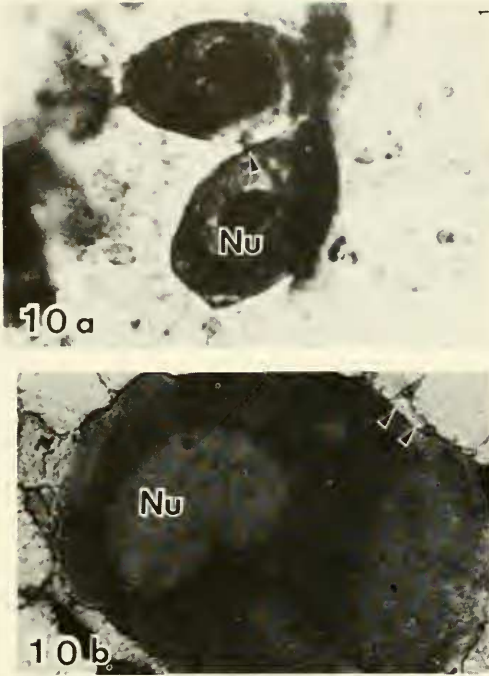
ble with limited magnification (Figs. 10a, 10b) (McCallum 1982). *Ichthyophthirius* in high numbers is detrimental since it can cover the gill respiratory surface. Agglomerate and benthic life stages are followed by an adult ectodermal phase (Farley and Heckmann 1980). In this stage *I. multifiliis* can burrow under the epithelium of its host, subjecting the fish to potential secondary infections.

The rapid multiplication of *Ichthyophthirius* is one reason it is so pathogenic (Hoffman 1967). The greatest mortality caused by this parasite was reported for channel catfish (*Ictalurus* sp.) (Hines and Spira 1973).

#### *Rhabdochona*: Nematoda

*Rhabdochona* is the only helminth from sculpin found during this survey. Several species of fish are parasitized by this genus of nematodes (Yamaguti 1961). *Rhabdochona cotti* was found in *C. bairdi* at four of the five collection sites. Larval development for *Rhabdochona* occurs in several species of mayfly nymphs (e.g., *Hexagenia*) (Gustafson 1941), thus the ready availability of the nematode for mottled sculpin. Not much is known concerning the pathogenicity of this parasite. A high percentage of infections by acanthocephalan parasites, another helminth, have been reported from winter collections in other surveys of sculpins (Amin and Burrows 1977), but the reason for the high rate of infection by *R. cotti* in the winter-spring season in this study is unknown.

Adult *Rhabdochona* inhabit the intestine of fish. Sections were taken of infected intestine



Figs. 10a, 10b. *Ichthyophthirius multifiliis* that infested the gill surface of *Cottus bairdi* from the Provo River, Utah. Note the large size of the ciliate, the horse-shoe-shaped macronucleus (Nu) and the cilia (arrow points). 10a, 100X; 10b, 430X.

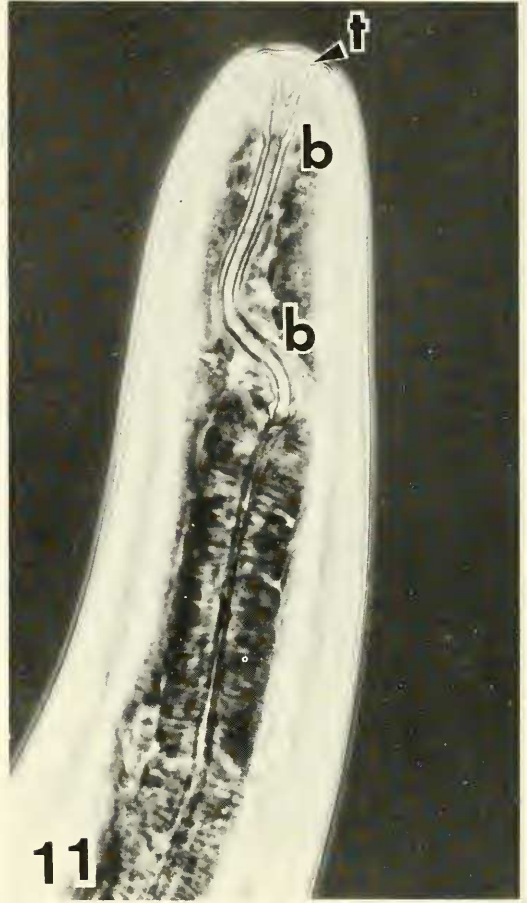


Fig. 11. *Rhabdochona cotti* was the only helminth observed during this study. This nematode was found in the intestine of *Cottus bairdi* and is characterized by a narrow buccal capsule (b) terminating anteriorly in pointed teeth (t). 100X.

containing this parasite and stained using a pentachrome stain (Fig. 11). It is suspected that this nematode has little pathogenicity; but in large numbers the potential for significant intestinal damage exists. The adult nematode has a characteristic buccal capsule with longitudinal ribs terminating anteriorly in pointed teeth (Fig. 11) (Hoffman 1967).

This study has complemented the known parasitofauna of *Cottus bairdi* with the addition of two protozoan species to the current list of 37 parasites (Table 2). There was a paucity of helminth parasites in the examined sculpin which were common for other collection sites (Heckmann 1983).

#### Ecological Comments

The greatest density of parasites observed, the highest number of species found, and the total number of parasites per fish came from *C. bairdi* inhabiting the Provo River near Brigham Young University (Table 1). This

area receives heavy impact from the local human population. In a pristine mountain stream, Hobble Creek, only two species of myxosporidan parasites were observed in 13 and 26% of the examined fish (Table 1).

#### ACKNOWLEDGMENTS

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